4. Facility and Environmental Requirements

This chapter includes mechanical, electrical, and cable plant standards and guidance for shipboard and shore/base environments, as well as ground combat and naval aircraft environments. The relationship of this chapter with the ITSG is shown in Figure 4-1.

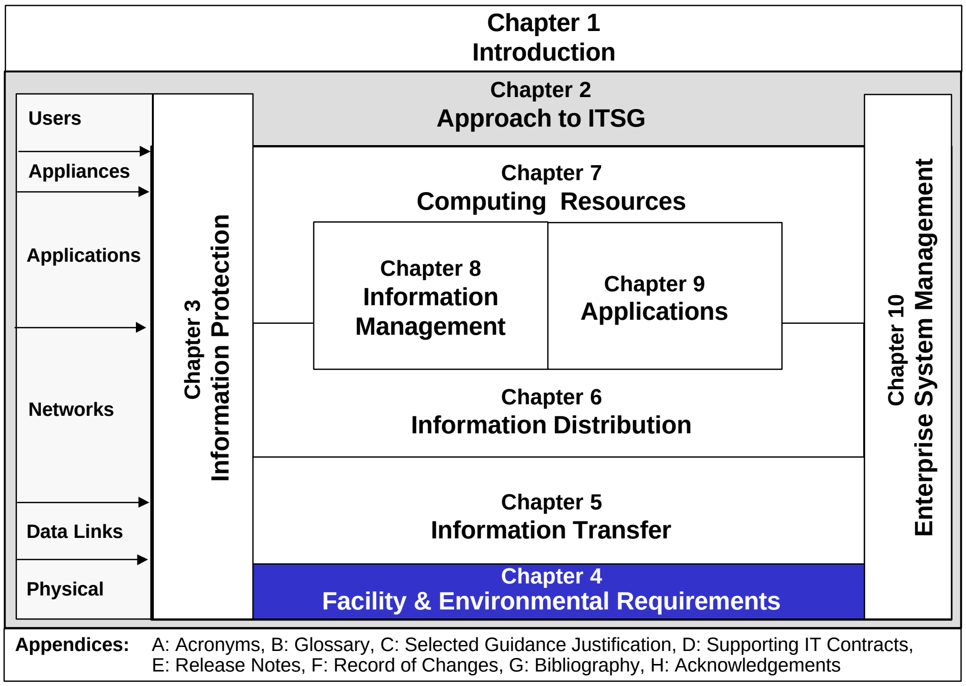

Figure 4-1. ITSG Document Map Highlighting Chapter 4, Facility and Environmental Requirements

4.1 Overview

The purpose of this chapter is to provide facility and environmental requirements for commercial off-the-shelf (COTS) Information technology (IT) components. Often, information processing equipment such as personal computers, are considered to be small electrical appliances that do not require additional considerations above those already present for the facility. Experience has shown that commercial off-the-shelf (COTS) equipment can survive and reliably operate within enclosed air-conditioned spaces of shore-based facilities and Navy ships provided that some reasonable and practical installation guidelines are followed. However, the number of “small” computers can add up and place a considerable load on the facility, particularly in the shipboard environment. Standards and specifications are well established for cabling, fire prevention, electrical safety, cooling, and physical security.

The goal of this chapter is to provide a complete and comprehensive set of facility specifications pertaining to IT implementation. These facility specifications are distributed among many different references pertaining to different platforms, operating environments, and physical technology. The current version of the ITSG does not exhaustively meet this goal, however, it does provide a placeholder to contain that information in the future.

4.2 Site Security

Classified site security requirements for facilities is provided in DoD 5220.22-M dated January 95, National Industrial Security Program Operating Manual (NISPOM).

4.3 Cable Plant

The cable plant includes copper cable, fiber optic cable, and wireless RF. Wireless optical devices currently satisfy only special-purpose requirements and are beyond the scope of the ITSG.

Best Practices

Fiber optic cable is the solid media preferred for its current high-capacity (100's of Mbps), future bandwidth potential (Gbps to Tbps), reliability, reduced susceptibility to Electromagnetic Interference (EMI), and security. (Although fiber cannot be made completely secure without encryption or proper physical protection, it cannot be "tapped" without physical manipulation.)

Fiber optic cable is required to support voice and high speed data. Fiber optic cable is recommended in other areas where feasible. If cost limits its use, then fiber optic cable should be run at least in the backbone of the network and to major junction points (telephone closets, for example). A mix of 62.5μm core/125μm cladding multimode and 8μm core/125μm cladding single-mode fiber should be pulled in jacketed bundles, terminated and tested. The cost avoidance of installing additional single-mode cable is relatively low compared to the future benefits it presents.

Copper cabling should be avoided in the backbone because it has inherently low bandwidth over significant distance. If copper is unavoidable, it should be limited to areas which can be easily, and inexpensively rewired with fiber when appropriate. If copper is used, select only properly-terminated and tested Category 5 ("Cat 5") cable for cable from the telecommunications closet to the desktop. (Unshielded Twisted Pair (UTP) Cat 5 is *the* copper standard for data rates up to 155 Mbps.) Thin-wire coax, thick-wire coax, RS-232/422, Category 3 and "telephone" wire should be avoided — the minor cost savings is not usually justifiable because of limited data rates and degraded interoperability. (Allowable exceptions are recognized when linking distant, or otherwise limited-access areas, which are already wired.)

Table 4-1 and Table 4-2 provide recommended implementations.

Recommended Implementations

	Current ITSG	Projected ITSG			
Not Recommended	**1999**	**2000**	**2001/2002**	**2003/2004**	**Emerging**
Coaxial Cable 10BASE5 (ThickNet) 10BASE2 (ThinNet) Thick Net Shielded Twisted Pair RS-232/422 Cat-3 Cable	MIL-F-49291 MIL-C085045 Air Blown Fiber (ABF) Zip Cord for Drop Cables UTP Cat-5 for Drop Cables after testing	MIL-F-49291 MIL-C085045 Air Blown Fiber (ABF) Zip Cord for Drop Cables UTP Cat-5 for Drop Cables after testing	MIL-F-49291 MIL-C085045 Air Blown Fiber (ABF) Zip Cord for Drop Cables UTP Cat-5 for Drop Cables after testing	MIL-F-49291 MIL-C085045 Air Blown Fiber (ABF) Zip Cord for Drop Cables UTP Cat-5 for Drop Cables after testing	Wireless IEEE 802.11
Activities, Platforms, Operational Environments		Ships			

Table 4-1. Cable Media Recommended Implementations for Ships

	Current ITSG	Projected ITSG			
Not Recommended	**1999**	**2000**	**2001/2002**	**2003/2004**	**Emerging**
Coaxial Cable 10BASE5 (ThickNet) 10BASE2 (ThinNet) Thick Net Shielded Twisted Pair RS-232/422 Cat-3 Cable	Mix 62.5 um core/125um clad multi-mode with 8um core/125um clad single-mode fiber Air Blown Fiber (ABF) Zip Cord for Drop Cables UTP Cat-5 for Drop Cables after testing	Mix 62.5 um core/125um clad multi-mode with 8um core/125um clad single-mode fiber Air Blown Fiber (ABF) Zip Cord for Drop Cables UTP Cat-5 for Drop Cables after testing	Mix 62.5 um core/125um clad multi-mode with 8um core/125um clad single-mode fiber Air Blown Fiber (ABF) Zip Cord for Drop Cables UTP Cat-5 for Drop Cables after testing	Mix 62.5 um core/125um clad multi-mode with 8um core/125um clad single-mode fiber Air Blown Fiber (ABF) Zip Cord for Drop Cables UTP Cat-5 for Drop Cables after testing	Wireless IEEE 802.11
Activities, Platforms, Operational Environments		Shore, ITSCs			

Table 4-2. Cable Media Recommended Implementations for Shore and ITSC Use

4.3.1 Definitions

4.3.1.1 Trunk Cable

A trunk cable is a cable that connects two main interconnection boxes or patch panels. It is used to provide connectivity between the service areas of the cable plant.

4.3.1.2 Local Cable

A local cable is a cable that connects a main interconnection box or patch panel to user system equipment or a local breakout box.

4.3.1.3 System Specific Cable

A system specific cable directly connects two pieces of user system equipment, independent of the cable plant. A system specific cable is typically used to connect equipment within the same service area of the cable plant.

4.3.1.4 Drop Cable

A drop cable is a system specific cable between a ready movable piece of user system equipment, such as a PC or printer, and the local breakout box in the area. A drop cable is not considered to be part of the cable plant.

4.3.2 Media

4.3.2.1 Fiber Optic Cable

Fiber optic cable is the preferred media for all network applications due to its growth potential. (In shipboard and other high Electromagnetic Interference (EMI) environments, fiber optic cable is critical in eliminating the effects of noise.) The backbone network must use fiber optic cabling, as part of the Fiber Optic Cable Plant (FOCP) — twisted pair (shielded or unshielded) or coaxial cable should not be used. Where possible, multimode graded index fiber with a 62.5 micrometer (µm) core/125µm cladding should be used. Due to the low relative marginal cost, single-mode fiber (8µm core/125µm cladding) should be provided in at least the backbone FOCP and preferably to major junction points.

Multimode fiber (62.5µm) is easier to terminate and test, especially in the field. However, there are distance and bandwidth limitations that cannot be overcome and single-mode fiber must be used. (Multimode fiber can support rates of up to 155 Megabits Per Second (Mb-ps) at distances up to 2 kilometers (km). It can only support 622 Mbps for hundreds of feet. Single-mode fiber (8µm), however, can easily support units of Gigabits Per Second (Gbps) at up to 30 kms. Further, it can support multiple wavelengths, each operating at units of Gbps. Thus today’s single-mode fiber can support tens of Gbps for tens of kilometers. Laboratory tests have shown this limit to be at least 2 orders of magnitude higher, namely Terabits Per Second (Tbps).

4.3.2.1.1 Testing Fiber Cable for Kink Susceptibility

Recent purchase of fiber optic cable has demonstrated a susceptibility to kinking that results in excessive optical loss. Contact Naval Sea Systems Command (NAVSEA) 03J for a test procedure that can detect this potential problem while the cable is still on the reel.

4.3.2.2 Unshielded Twisted Pair (UTP)

Category 5 UTP cable may be used only for the cabling between the appliance and the network edge device or between the workstation and other network equipment under certain conditions. Shielded Twisted Pair (STP) cable should not be used. The following factors should be taken into consideration when using Category 5 UTP cable:

- Mission criticality of the application (The UTP copper cable may exhibit a lower availability than fiber due to EMI problems.)
- Bandwidth or signaling rate (UTP may be used for short runs of 100BaseT, but should not be used at higher data rates or for long runs.)
- Security level (UTP is easy to tap if not run in conduit.)
- Length of cable run (UTP should be limited to intra-compartment runs.)
- Installation factors (UTP requires exceptional care during installation, and should be thoroughly tested.)
- Environmental factors
- EMI (UTP is subject to interference from radar and nearby high-powered equipment.)

In shipboard environments, UTP cable should meet the flammability, smoke, acid gas generation, halogen content, and toxicity index requirements noted in the previous section for fiber cable. Further, UTP should be limited in mission critical systems to non-critical components due to EMI, shock and vibrations (commercial RJ-45 plastic connectors for UTP are not designed to withstand significant shock loads and may crack or disconnect under long-term vibration conditions).

4.3.2.3 Legacy Copper-Media Networks

For installations with copper-based legacy systems, it is recommended that those systems be selectively upgraded to fully integrate users of the backbone network based on capability requirements and funding availability. In the case of remote runs, particularly on large shore installations, legacy copper may not be replaced for a significant period of time, if ever. Alternate technologies, such as cable modems or Digital Subscriber Line (DSL), may be the only mechanism for providing high-bandwidth access. (A relevant example would be a guard shack located many miles from the nearest network access point. Should this outpost need multiple Mbps for a video circuit (camera or monitor), an existing POTS line may be all that is ever available. In this case, a DSL modem may suffice.) Again, it is strongly preferred that all copper infrastructure be replaced with fiber — even if it takes years.

In shipboard environments where the ship's decommissioning schedule, upgrade funding availability, or system requirements cannot support the decision to upgrade the system, connectivity to the ship's backbone network can be accomplished at either the backbone or workgroup switch, providing that the legacy network protocols can be supported by those devices. In such a configuration, the backbone network switch acts as a gateway between the legacy system and the rest of the backbone. If some limited funding for system upgrade is available, and such upgrades suit the needs of the ship, a lower cost interim upgrade would be to replace the legacy copper links with fiber optic links, and integrate those links into the ship's FOCP. This interim physical integration will simplify the further upgrade from a separate legacy system to an integrated network application.

4.3.2.4 Shipboard Environment

In shipboard environments, the fiber should meet the requirements of MIL-F-49291. The fiber optic cables should meet the requirements of MIL-C-85045 (including, but not limited to, flammability, smoke, acid gas generation, halogen content, and toxicity index). A requirement for the use of Air Blown Fiber (ABF) as an alternative installation technique for fiber optic cabling in ships is under development. Specific requirements for ABF use will be provided at a future date.

4.3.2.5 Shore/Base Environment

In shore and base environments, the fiber optic cable's outer jacket composition must comply with National Fire Protection Association (NFPA) standards that address use within plenums. Electrical code must be followed when non-dielectric-strength members are used (e.g., for additional support or rodent protection.) Building interior backbones should nominally consist of 24 multi-mode fibers and 12 single-mode fibers with the actual numbers determined by the local command. For building and base exterior backbones, runs of 2 km or less will use composite cable consisting of 8 multi-mode fibers and 4 single-mode fibers. Runs greater than 2 km should consist of single-mode fibers; the number to be determined by the local command or the ITSC. For tough or long cable pulls, 200-Kilo-Pounds-per-Square-Inch (KPSI)-rated cable is recommended, otherwise 50-KPSI-rated cable is acceptable. Area installations will use dielectric-strength members to provide lightning protection. All runs will be supported to prevent excessive sagging.

4.3.2.6 Pier and Mooring Stations

A 12-fiber composite cable and covered connectors should be run from the pier junction box to each pier berth. The outer jacket is ruggedized and weatherproof. Umbilical cables will be used to connect the pier mooring station to the ship junction box. The cable itself should be a composite cable consisting of 8 multi-mode fibers and 4 single-mode fibers per Section 4.3.2.1.

4.3.2.6.1 Pier Trunk Cable

The pier trunk cable shall have a heavy duty PVC outer jacket designed for direct burial, underground duct, steam tunnel, or aerial-lashed installation. It shall be designed for water blocking per EIA/TIA-455-82B and operating temperatures from -40C to +85C.

4.3.2.6.2 Umbilical Cable

The umbilical cable shall be suitable for tactical field use in severe environmental conditions. There are two polyurethane outer jackets that should be separated by an E-glass yarn for maximum flexibility. The outer jacketing shall be designed for maximum abrasion, cut, and chemical resistance over a wide temperature range (-55C to +85C). Internal construction should have two separate layers of Kevlar for maximum crush resistance and resilience (DOD-STD-1678).

4.3.2.6.3 Shipboard Trunk Cable

The shipboard cable connecting the mooring stations to the junction box in the radio room should have the same outer jacketing construction as the umbilical cable except that there is a single outer jacket. The jacketing shall be UV inhibited, flame retardant, and moisture/fungus resistant. The internal construction shall have sub-cable jacketing that separates the internal fibers into pair groupings.

4.3.3 Patch Panels, Interconnection Boxes and Connectors

<u>Recommended Implementations</u>

The recommended implementations for the patch panels, interconnection boxes, and connectors is provided in Table 4-3 and Table 4-4 for ship and shore implementations respectively.

	Current ITSG	Projected ITSG			
Not Recommended	**1999**	**2000**	**2001/2002**	**2003/2004**	**Emerging**
MIC fiber connectors	MIL-I-24728 for interconnection boxes MIL-C-83522/16 ST connector for multimode fiber FOPC connector for single mode fiber RJ-45 for UTP cable	MIL-I-24728 for interconnection boxes MIL-C-83522/16 ST connector for multimode fiber FOPC connector for single mode fiber RJ-45 for UTP cable	MIL-I-24728 for interconnection boxes MIL-C-83522/16 ST connector for multimode fiber FOPC connector for single mode fiber RJ-45 for UTP cable	MIL-I-24728 for interconnection boxes MIL-C-83522/16 ST connector for multimode fiber FOPC connector for single mode fiber RJ-45 for UTP cable	SC connector for multimode fiber
Activities, Platforms, Operational Environments		Shipboard			

Table 4-3. Patch Panels, Interconnection Boxes and Connectors Recommended Implementation for Shipboard Use

	Current ITSG	Projected ITSG			
Not Recommended	**1999**	**2000**	**2001/2002**	**2003/2004**	**Emerging**
MIC fiber connectors ST fiber connectors.	SC connector for multimode fiber FOPC connector for single mode fiber RJ-45 for UTP cable	SC connector for multimode fiber FOPC connector for single mode fiber RJ-45 for UTP cable	SC connector for multimode fiber FOPC connector for single mode fiber RJ-45 for UTP cable	SC connector for multimode fiber FOPC connector for single mode fiber RJ-45 for UTP cable	
Activities, Platforms, Operational Environments		Shore and ITSC			

Table 4-4. Patch Panels, Interconnection Boxes and Connectors Recommended Implementation for Shore and Base Use

4.3.3.1 FOCP Interconnection Boxes

FOCP interconnection boxes and patch panels should hold a minimum of 48 connector pairs. Interconnection boxes should be sized to accommodate all of the fibers (allocated, spare, and growth) that enter the box.

4.3.3.2 Local Breakout Boxes

Local breakout boxes may be used to provide additional flexibility in locating workstations or easily moved equipment. The interconnection box should completely enclose the fiber terminations. Local breakout boxes should not be used as a substitute for rack-mounted patch panels for the interconnection of rack-mounted equipment.

4.3.3.3 Location of Tx-Rx Pairs and Optical Crossover

In FOCP Interconnection Boxes, local breakout boxes, and in rack-mounted patch panels, the pair of ST connectors associated with one full-duplex optical circuit should be located in a vertical line, one above the other, with the transmit (Tx) connector above the receive (Rx) connector. In a complete optical link, there must be one (or an odd number of) crossovers in order to connect the optical transmitter at one end to the optical receiver at the other end, and vice versa.

4.3.3.4 Shipboard Environment

In shipboard environments, interconnection boxes should meet the requirements of MIL-I-24728. Breakout boxes should be in accordance with MIL-I-24728/4 or /5, and should be mounted within the same compartment as the equipment they serve

4.3.3.5 Shore/Base Environment

In shore and base environments, all cabling will be terminated in lockable fiber optic patch panels. Patch panels will have splice trays or allowances for splices for the single-mode fiber. A minimum of 25 foot service loop will be used at each end of the cable for interior building backbones and 50 foot service loop for exterior building/base backbones. Tight buffered construction will be used and the cables should be supported. For exterior/base backbones, tight buffered construction will be used unless outer cable diameter or high moisture environments required use of gel-filled cable. All gel-filled installations will use the proper blocking kits to prevent gel creep. The cables should be supported to prevent excessive tension or compression.

4.3.3.6 Pier and Mooring Stations

On board the ship, ruggedized, weatherproof fiber optic junction boxes with weatherproof fiber optic patch panels are required at both the port and starboard mooring stations. Submarines will have one junction box with two connections. On the pier, ruggedized weatherproof fiber optic junction boxes with patch panel uplinked to the base area network and downlinked to each pier berth are required.

4.3.4 Connectors

4.3.4.1 Fiber Optic Cable

4.3.4.1.1 ST-type

ST-type connectors were, until recently, the standard for all multimode connections. In commercial applications, SC is rapidly becoming the standard. It is becoming hard to find host network interface cards with ST connectors.

4.3.4.1.2 SC-type

SC-type connectors are becoming the industry standard for both host network interface cards and backbone connections. While this is acceptable for multi-mode fiber, it has debatable merit for single-mode fiber. (Pros: more common connector, easier to insert/remove; Cons: can more easily confuse multi-mode with single-mode fiber, if single-mode transmitter accidentally plugged into multi-mode receiver, the receiver could be permanently damaged.) The choice for shore-based systems is not critical.

4.3.4.1.3 FCPC-type

FCPC-type connectors are the standard for single-mode fiber. Many equipment vendors, however, are beginning to use SC-type connectors. Because the risk of accidentally switching multi-mode and single-mode connections exists when the same connector is used for both, it is recommended that FCPC-type be used for single-mode fiber (see discussion in the previous paragraph).

4.3.4.1.4 MIC-type

MIC-type connectors are not recommended for use within the backbone network. However, if MIC-type connectors are the only available option, it is recommended that a MIC-ST jumper cable be fabricated to allow the MIC connector at the equipment interface, but with an ST connector for connection to the FOCP or rack-mounted patch panel. MIC connectors should not be used within FOCP interconnection boxes.

4.3.4.1.5 Heavy-Duty Multiple Terminus

Heavy-duty multiple terminus connectors are recommended for equipment interfaces that require a rugged interface that is easily disconnected and reconnected. These connectors should be in accordance with MIL-C-28876, except for ship-to-shore pier connections which will comply with requirements stated in section 4.3.4.5.

4.3.4.1.6 Mechanical Splice

Mechanical splices are recommended only for those applications requiring higher optical performance than is available with ST-type connectors. Mechanical splices should meet the requirements of MIL-S-24623. Mechanical splices may be used in interconnection boxes, and may also be used inside rack-mounted patch panels where needed for higher optical performance.

4.3.4.2 Copper Cable

4.3.4.2.1 RJ-45 Connectors

Category 5 cable specifications limit the connector type to RJ-45. However there are a number of pin-out standards from which to choose. Because ISDN also specifies the use of RJ-45, the ISDN pin-out specification will be used: ANSI/EIA/TIA-568-1991 Standard, Commercial Building Telecommunications Wiring. This standard defines pin-outs as shown in Figure 4-2. This variant is designated EIA/TIA T568A (also called ISDN, previously called EIA).

Figure 4-2. RJ-45 Pin Specifications for T-568A

4.3.4.3 Shipboard Environment

In shipboard environments, ST-type connectors are recommended for all light-duty multi-mode fiber applications. For FOCP connections inside interconnection boxes, the connectors should be in accordance with MIL-C-83522/16. ST-type connectors may be used as the interface to equipment if sufficient cable strain-relief and protection are provided. Failure to provide sufficient strain relief and protection will result in connector breakage or failure.

Until such time as SC-type connectors are evaluated against shock, vibration and wear, they are not recommended for use within the backbone network. However, if SC-type connectors are the only available option associated with the network equipment, it is recommended that an SC-ST jumper cable be fabricated to allow the SC connector at the equipment interface with an ST connector for connection to the FOCP or the rack-mounted patch panel. SC connectors should not be used within FOCP interconnection boxes.

4.3.4.4 Shore/Base Environment

In shore/base environments, SC-style connectors are recommended. Duplex connectors are recommended at the terminal ends of the workgroup and network device ends. Patch panel jumpers should be simplex to allow for rerouting of separate cables. Ceramic ferrules are recommended for superior loss and polishing characteristics. Wall-mounted faceplates are recommended. Zip cord is recommended for the drop cables from the wall faceplate to the appliance. UTP with standard RJ-45 connector is acceptable as well.

4.3.4.5 Pier and Mooring Stations

A ruggedized, weatherproof, 12-pin fiber optic connector will be used to connect the pier berth to the umbilical and the umbilical to the ship mooring station junction box. The umbilical will also be used to connect between ship junction boxes for ships nested outboard. The connector itself should be hermaphroditic (“genderless”) for greater simplicity over male-female connectors. The hermaphroditic connector should be a 12 pin connector consisting of 8 pins multi-mode optical fiber and 4 pins single mode optical fiber. The termini should be MIL-T-29504/14 & /15.

4.3.5 Topology, Security & Integrated Cabling

Recommended Implementations

	Current ITSG	Projected ITSG			
Not Recommended	**1999**	**2000**	**2001/2002**	**2003/2004**	**Emerging**
	Mesh Topology MIL-STD-2042 for ships cabling MIL-HDBK-2051 for ships ANSI/TIA/EIA 568A, 569 for shore	Mesh Topology MIL-STD-2042 for ships cabling MIL-HDBK-2051 for ships ANSI/TIA/EIA 568A, 569 for shore	Mesh Topology MIL-STD-2042 for ships cabling MIL-HDBK-2051 for ships ANSI/TIA/EIA 568A, 569 for shore	Mesh Topology MIL-STD-2042 for ships cabling MIL-HDBK-2051 for ships ANSI/TIA/EIA 568A, 569 for shore	
Activities, Platforms, Operational Environments		All unless otherwise noted.			

Table 4-5. Topology, Security, Cable Integration Recommended Implementations

4.3.5.1 Basic Topology

The recommended physical topology is a mesh, as opposed to a ring or star configuration. If a logical ring or star topology is required for near-term cost reasons, the physical mesh cable plant infrastructure can be configured to provide the required logical topology. The mesh physical architecture will support the future expansion or upgrade to a full mesh logical topology.

4.3.5.2 Network Node Locations

Node locations should be selected based on the concentrations of current and planned network users. Nodes should be located in secure areas, to preclude unauthorized access to the equipment. Nodes should also be located in temperature controlled compartments, to optimize equipment reliability. Note that there is a trade-off between the number of nodes and the total quantity of local cable required to connect users. These two parameters should be considered in conjunction with the system requirements for survivability when determining the appropriate number of nodes.

In shipboard environments, users should be connected to nodes within the same fire zone for survivability. Also, the number of nodes installed should be selected to provide maximum coverage of the ship’s fire zones, while minimizing the total network cost.

4.3.5.3 Patch Panel And Interconnection Box Locations

Main interconnection boxes or patch panels should be collocated with the network nodes. For maximum installation and connection flexibility, it is recommended that the patch panels be installed in the same rack as the network node equipment. These rack-mounted patch panels can also be used to provide a convenient means of interconnecting equipment within the same rack, and to provide a simplified disconnect point in the event that racks must be moved.

In shipboard environments, interconnection boxes should be in accordance with MIL-I-24728 and be bulkhead mounted. For racks containing connection-intensive network devices, the use of a rack-mounted patch panel should be considered to serve as the interconnection box for that zone.

4.3.5.4 Trunk Cable Routing

In general, trunk cables should be routed along diverse physical paths to ensure a survivable FOCP. The degree of redundant/fail-over equipment is cost-driven but with a proper FOCP mesh, outages can be quickly restored using alternate cable paths.

In shipboard environments, trunk cables should be routed to provide survivable signal paths between interconnection boxes in accordance with the requirements of MIL-STD-2042. In general, each trunk cable should have an identical redundant cable following a separate route between the two interconnection boxes. The separation recommendations are to be followed for distributed systems, as defined in Section 072 of the applicable ship specification. In addition, the cables should be routed on opposite sides of the ship, with at least two decks separating them vertically. If possible, it is desirable to have one of the runs located primarily below the damage control deck, and the other above the damage control deck, but this must be factored along with technical and cost feasibility guidance.

4.3.5.5 Local Cable Distribution

In shipboard environments, local cables should be routed in accordance with the requirements of MIL-STD-2042. If a single user has multiple local cables for redundancy or survivability, those local cables should be routed to two different interconnection boxes, and should be separated within 60 feet of the equipment.

4.3.5.6 Network Fiber Allocations

4.3.5.6.1 Inter-node

Fibers should be allocated for all inter-node connections. The level of inter-node connectivity should be determined based on current technical requirements, future projections of requirements, and overall program cost constraints. In general, it is desirable to include sufficient fiber in the FOCP to allow for full inter-node connectivity in a mesh topology. Any interim logical configurations, such as rings or stars, should also be considered when determining fiber requirements.

4.3.5.6.2 Redundancy

Redundant fibers in survivable separated trunk cables should be provided for each active and spare user system fiber. This is particularly critical in shipboard environments.

4.3.5.6.3 Spares

Spare fibers should be provided on a 100% basis; that is, each actively used fiber should have an assigned spare. This is particularly critical in shipboard environments.

4.3.6 Cable Security

In general, the requirements of National Security Telecommunications and Information Systems Security Advisory Memorandum (NSTISSAM) TEMPEST 2/95, RED/BLACK Installation Guidance apply. Further explanation and recommendations on security related topics are provided below.

4.3.6.1 Use of Separate RED and BLACK Cables

Per the TEMPEST guidelines, separate multifiber cables should be used for RED and BLACK systems. However, these cables may be in the same trunk group.

4.3.6.2 Use of Conduit for RED Cables

Encasing RED cables in conduit does not provide an additional level of security commensurate with the associated costs (including weight and volume impact on the ship).

4.3.6.3 Locking Interconnection Boxes

Interconnection boxes containing RED fibers should be locked, or located inside a secured space. Locating the boxes in a secure space is the preferred option.

4.3.6.4 Separation of RED and BLACK Fibers Inside an Interconnection Box

For maximum security, separate RED and BLACK interconnection boxes should be used. If separate boxes are cost prohibitive, an alternative is to use separate patch panels in the same interconnection box for RED and BLACK terminations. If only one patch panel is used, RED and BLACK fibers should be segregated to prevent mis-connections.

4.3.6.5 Connector Selection

The TEMPEST guidelines recommend using incompatible connector types for RED and BLACK connections. For multifiber (heavy-duty) connectors, this can be accomplished by specifying an alternate keying arrangement for RED connectors. Within interconnection boxes, there are two connection options -- the light-duty, single-fiber connector and the rotary mechanical splice. The rotary splice is a high performance termination that is more expensive and best suited to specific applications requiring very low insertion loss terminations. Therefore, it is recommended that the selection of termination type inside the interconnection box should be governed by the system’s optical performance requirements, rather than security classification level. In addition, the practice of using light-duty connectors with a different color boot is recommended as a way to distinguish RED versus BLACK connections.

4.3.6.6 Labeling and Marking

The current General Specification (GENSPEC) labeling and marking conventions for cables and fibers do not have any provisions for handling RED versus BLACK designations or Transmit versus Receive ends of a fiber. It is recommended that, upon installation, RED fibers be labeled as such using an extra heat shrink sleeve. These labels should only be added after the cable jacket is stripped off exposing the individual OFCCs. Note that all fibers in the RED cables should be labeled as such, including spare and growth fibers, since mixing RED and BLACK fibers in the same cables is not permitted. It is further recommended that the transmitting end of a fiber (the end from which light exits if the connection is opened) be labeled “T” or “Tx” and the receiving end be labeled “R” or “Rx”.

4.3.6.7 Sharing of Trunk Fibers

Each fiber in a trunk cable is reserved for one unidirectional optical communication link for one transmitter/receiver pair. No near-term plans are in place to permit wavelength division multiplexing, or to put multiple light signals down the same fiber. The fibers within a particular trunk cable may be allocated to different equipment within the same system, or even different systems, subject to the information security provisions described above. However, each fiber provides a completely isolated communication path from all the other fibers in the cable.

4.3.6.8 Sharing of Interconnection Boxes

Multiple user systems will share the same fiber optic interconnection boxes, again subject to the aforementioned security requirements.

4.3.7 Cable Plant Integration Guidance

4.3.7.1 Use Of Existing FOCP

When an installation already has an FOCP, a new network should make maximum use of the existing FOCP. At a minimum, every attempt should be made to make use of growth capacity within the FOCP interconnection boxes or patch panels, even if additional cabling must be installed to support the network connectivity requirements.

4.3.7.2 Shipboard Implementation Guidance

The shipboard cable plant provides the physical layer fiber optic connectivity for networks and other user systems on the ship. The fiber optic cable plant (FOCP) supports multiple ship service areas. Each service area is provided with one or more fiber optic interconnection boxes to allow cable plant access for the user equipment. From the interconnection box, fiber optic connectivity to other service areas is provided through redundant, survivable separated fiber optic trunk cables. The design guidance of MIL-HDBK-2051 and MIL-STD-2052A, as well as the installation requirements of MIL-STD-2042, applies to all ship fiber optic cable plants.

4.3.7.3 Shore Based Implementation Guidance

ANSI/TIA/EIA 568A,569 are the core of a popular family of commercial cabling standards for building and campus telecommunications infrastructure. These standards support telecommunications applications for current and emerging voice, video and data applications. Through active participation and consensus, North American telecommunications manufacturers, designers, consultants, and commercial and government users develop the standards. (Although the primary focus of this group is the North American marketplace, members provide liaison with international standards bodies and also serve as representatives in the United States Technical Advisory Group and Canadian Standards Association.) In addition to these standards, Type I security requirements are established for conduit and/or alarms.

4.3.8 Cable Plant Management

Requirements

It is recommended that all installations have a reliable and accurate cable plant management system. The system shall be integrated into the enterprise management system (Chapter 10). The Web-Based Enterprise Management (WBEM) specification provides guidelines for integration.

A number of cable plant management packages exist that meet the DON requirements. In shipboard environments in which damage control is part of the routine, it is especially critical to have a robust system. The following is recommended for this environment and encouraged for all environments.

Physical and Logical Network View. Users should be able to examine the network physical connections from a high-level topological view down to the fiber and port level via a 3-D graphical representation of the networking environment. Users should also be able to examine the logical connections of the network. The software should display multiple ship decks with Naval isometric format in a single window viewport. It should display in a single window viewport the fiber optics backbone across multiple ship decks. Classified and unclassified networks must be displayed in different colors. Also, individual user systems and their cables must be displayed in different colors.

System Requirements. The software should be built upon advanced COTS Open-GL 3D graphics engine, Relational Data Base Management Systems (RDBMS), and trouble-ticketing software. It should be able to handle DON specific cable plant requirements. It should be able to import multiple ship electronic drawings and compartmentation booklets, and integrate these into a single Naval isometric drawing format. The RDBMS software should provide the users with a robust database management tool and report generation capability. The integrated system should enable recognition of components and cable connections across the individual COTS-based software products (database, troubleticketing, network management tool, cable management software) that comprise the integrated product.

Network Equipment Asset Accounting. The software should provide cable asset management, complete with defect reporting and asset tracking and reporting functionality.

Trace Path Function. The software should provide a single window viewport and “any-to-any" cable trace path capability – from any active network components and passive cable plant components to any other active network components and passive cable plant components. This capability will allow users to dissect the connectivity of the network components and to reroute connections from the shortest path (if that connection is "down") to the next shortest spare/redundant path.

Change Management. The software should allow users to manipulate (add, modify, describe, delete) network components. These components consist of communications devices, switching hubs, ATM switches, junction boxes (Navy-specific FOICBs), patch panels, splice-trays, pig-tails, media converters, outlets, trunks, fiber cables and copper cables. The system must address fiber optics and copper cables and connectors.

Dynamic Routing And Cable Tracking. The software should provide program recommendations to allow network managers to re-route communication paths dynamically and quickly when existing paths are damaged or destroyed. Thus, under the most severe battle conditions, the cable plant management capabilities will provide the ship with continued communications as long as alternative paths are available for re-routing purposes.

Fault Reporting. The system administrator should be able to detect a fault, to determine the location of the physical problem, and to issue a maintenance request in one unbroken sequence.

Security. The software should provide at least three levels of security login: read-only, integrator, and system administrator.

Help Function. The software should offer extensive online help complete with a glossary that defines the terms used in the program.

Specifications that support these functions are addressed in Chapter 10. Remote Network Monitoring version 2 (RMON2) and the Simple Network Management Protocol (SNMP) are the two current specifications.

Best Practices

Use Simple Network Management Protocol (SNMP) version 1 and Remote Network Monitoring Protocol version 2 (RMON 2) to manage IP networks and integrate the network management system into the DON enterprise management system.

4.4 Shipboard Facility Requirements

4.4.1 Racks

Shipboard networking equipment should never be installed by setting them upon desks, tables, filing cabinets, etc. Small equipment can be bulkhead-mounted or hung from the overhead; however, the preferable technique for shipboard installation of COTS networking equipment is in racks.

Suitable racks can be obtained from a number of vendors. However, heavy duty, industrial grade or ruggedized racks should be used, not lightweight racks intended for office environments.

Standard rack widths are 19” and 24”. Nearly all COTS networking equipment is designed to fit into 19” wide racks. (Note that these are mounting widths; the overall external width of a 19” rack is about 24”, and the outside width of a 24” rack is about 30”.)

Standard 19” racks come in several depths, typically 17”, 24”, 29” and 36”. When deciding on the depth of a rack, remember to allow enough depth for recessing equipment that have front-access cabling, and to allow air exhaust space for equipment with rear-facing fans. Many pieces of networking equipment have modular assemblies that are removed from the front, and the cables attach to these assemblies from the front. This requires that the unit be recessed at least 4” to allow a reasonable cable bending radius. (For units that have rear-accessible modules, it is often desirable to mount them in backwards for easier access to removable modules.)

If there is sufficient space in the shipboard compartment to mount the racks away from the bulkhead for both front and rear access, a sufficiently deep rack will permit electronics units and fiber patch panels to be placed back-to-back at the same vertical level within the rack.

Consider cable entry when ordering racks. If the rack is to be located on a raised false deck, then the cabling can enter from the bottom. Otherwise the cable should enter the rack from the lower half of the rear panel. For all cable entrances, a minimum of three inches of slack should be provided to allow for movement of the rack under shock and vibration. There should also be a minimum length of 18 inches between the last cable support and the cable's entrance to the equipment.

Racks should be ordered with removable, but lockable, side, front and rear panels for maximum equipment accessibility. Note that the location of louvers in rack panels depends upon the cooling method that is used (see below).

The location of equipment within racks is a trade-off among the sometimes conflicting parameters of accessibility, weight, and cooling. Heavy equipment should be located low in the rack for stability and ease of removing. Equipment that requires reading of displays, LEDs, or patching should be located at eye level. Heat-dissipation equipment should be located near the air exhaust, not near the cold air inlet, to avoid pre-heating the air flowing over the rest of the equipment.

Heavy equipment should be mounted using front-to-rear angle brackets or slide trays to simplify installation and removal, and to avoid the need to carry the weight of the equipment on the front-panel screws.

4.4.1.1 Cooling

Racks that contain equipment whose total power dissipation is more than 100 watts should be provided with rack-mounted blowers or fans to augment any cooling that might be provided by fans inside the equipment.

The cubic-feet-per-minute (CFM) rating of the rack blower/fans can be estimated from the following equation:

$$CFM = 4P/T$$

where

CFM = airflow in cubic feet per minute

P = Total rack power dissipation in watts

T = Temperature rise (inlet to outlet) in degrees Fahrenheit.

For example, a rack with 1000 watts of electronics will need a 400-CFM blower to limit the temperature rise to 10 ^{o}F.

Since heated air tends to rise, the airflow from fans or blowers should be bottom-to-top. This means placing a blower at the bottom of the rack, or an exhaust fan at the top of the rack. In either case, a washable air filter should be placed at the air entry point. Note that the blower, as opposed to the exhaust fan, has the added advantage of putting a positive pressure within the rack to keep out dust and dirt from unfiltered air entry.

If a blower is placed at the bottom of the rack, then the rear and/or side panels should have louvers near the top for exhaust air to exit. Do not use fully-louvered panels that would short-circuit the air flow. If exhaust fans are used, then the doors and panels should have no louvers; the cold air enters from the air filter near the bottom and the warm air exits via the top-mounted exhaust fan.

4.4.1.2 Shock Isolation

Shipboard racks should not be hard-mounted to deck foundations, but should be shock isolated via coil springs or other acceptable isolation mechanisms. Tall racks (over 5’ tall) should also have shock-isolated anti-sway mounting from the top of the rack to the bulkhead or to the overhead.

4.4.1.3 Line Conditioning and UPS

Shipboard AC power is notoriously unreliable, noisy, and subject to over-voltage and under-voltage conditions that can seriously damage COTS networking equipment. COTS network equipment should never be connected directly to shipboard power without the protection of a line conditioner and an uninterruptable power supply (UPS). (Printers need not be connected to UPS.)

Line conditioners protect against over/under voltage conditions, and provide some degree of noise suppression, but do not protect against total loss of power. UPSs provide over/under voltage protection, noise suppression, and supply AC power (generated from DC batteries within the UPS) for a limited time. (The loss-of-power protection interval varies with the size of the UPS batteries, but is typically about 15-20 minutes when the UPS is operated at 50% of rated load.)

Unlike shore-based AC distribution systems, shipboard power uses an ungrounded (floating) neutral. If ordinary line conditioners or UPSs are connected to shipboard power, the grounded neutral will cause a ground-fault indication. Line conditioners and UPSs with floating neutral can be obtained, but they must be special-ordered for shipboard service.

4.4.2 Electrical System Interfaces

4.4.2.1 Electric load analysis

Prior to installation, an electric load analysis should be performed to calculate the electrical system impact associated with the new equipment, taking into consideration any removed equipment as well.

4.4.2.2 Local distribution

If adequate electrical distribution is not available to supply the new loads, install additional equipment and cable as required. All electrical installations should be in accordance with DOD-STD-2003. All electrical cabling should be in accordance with MIL-HDBK-299. If the existing electrical distribution system is modified, circuit breakers and cables should be examined for adequacy and modified or replaced as necessary to support the new loads.

4.4.2.3 Bonding and grounding

Secure electrical information processing equipment and cables should be bonded and grounded in accordance with MIL-STD-1680. All other equipment and cable shields should be bonded and grounded in accordance with MIL-STD-1310. Bonding straps required should be fabricated in accordance with MIL-S-24729.

4.4.2.4 Power Source for Backbone Switches

Backbone switches should be supplied AC power from two independent power sources via an automatic power bus transfer system.

4.4.3 Air Conditioning

Prior to installation, the ability of the existing ship's air conditioning system (High Volume Air Conditioning (HVAC) system) to support the equipment installations in each compartment on the ship must be verified. If required, the air conditioning system should be modified in accordance with NAVSEA 0938-LP-018-0010.

4.4.4 Satellite Communication Equipment Requirements

Both military and civilian Satellite Communication (SATCOM) Systems installation requirements are coordinated between the originating Program Office and the Naval Sea Systems Command (NAVSEA). Positioning of above deck equipment such as antennas and remote amplifiers is controlled by mission requirements, suitable installation facility sites, and programmatic realities. Issues typically addressed include:

- Safe access by maintenance personnel
- One-antenna installation
  - Unobstructed visibility of the sky
- Two-antenna installation
  - Maximize the look angles of mutual coverage and provide total visibility of the sky
- Stable antenna mounting surface that does not oscillate during antenna motion
- Close proximity to below-deck equipment to reduce control and signal line losses
- Analysis of ships overturning moments

Figure 4-3 provides weight, volume and power characteristics for each shipboard SATCOM system.

Equipment Name	Above Deck Equipment		Below Deck Equipment		Power (W)
	Deck Surface Area (m^2)	Weight (kg)	Volume (m^3)	Weight (kg)	
UHF SATCOM					
AN/WSC-3	5	240x2	0.1	148	600
AN/SSR-1	1	20	0.1	20	200
SHF SATCOM					
AN/WSC-6	5	272	5	500	50,000
AN/SSC-6	3	272	43 (van)	1500 (van)	69,000
AN/WSC-2	6	1,225	7	900	32,000
AN/SSC-7	3	500	5	550	16,000
EHF SATCOM					
AN/USC-38 SHIP	5	550	1.2	737	4275
AN/USC-38 SUB	0.05	40	1.1	692	4050
Commercial SATCOM (INMARSAT & other high data rate systems)					
Inmarsat-A	1.2	100	0.05	20	300
Inmarsat-B	1.2	100	0.05	20	300
Inmarsat-C	0.02	2	0.05	3	150
Inmarsat-M	0.3	30	0.05	20	200
Intelsat, DirectPC, Orion, Teledesic, Celestri	Certified shipboard data is not available				

Figure 4-3. SATCOM Nominal Physical Characteristics

4.4.5 Special Considerations for Shipboard Mission Critical Signals

4.4.5.1 Shock

Equipment shall meet grade A shock requirements. Equipment shall operate before, during and after shock conditions resulting from high impact shock testing of hardware, mounting rack, and shock mounting devices. For critical signals that cannot accept momentary disruption of a circuit, multi-mode fiber is preferred over single-mode fiber because multi-mode fiber connectors withstand shock more readily than single-mode connectors.

4.4.5.2 Humidity

Using COTS hardware in environments with condensing 100% relative humidity can lead to shorting of printed circuit cards which are normally not conformally coated in COTS equipment. One solution to this problem is the use of specially treated equipment rooms (node rooms) or controlled spaces where highly-reliable air conditioning is always available.

4.4.5.3 Temperature

Most COTS electronic equipment is designed to temperature ranges of 0^{o}C to 30^{o}C, 40^{o}C or 50^{o}C. Shipboard operation outside of this range can cause failure or improper operation of LED displays, hard drives and CD-ROM drives at the low temperature extremes, and power supplies and other electronics at the higher temperature extremes. The concept noted in the previous paragraph of air-conditioned node rooms can be used to solve this problem. Temperature testing shall be tailored in accordance with MIL-STD-810, Method 501 or Method 502 and conducted with the equipment operational in a controlled environment of 0^{o} C to 50^{o}C.

4.4.5.4 Magnetic Field

The high magnetic fields caused by ship degaussing can disturb the displays on CRT screens. If critical information needs to be read during degaussing, consider the use of flat-panel displays instead of CRT displays.

4.4.5.5 Vibration

Each rack of COTS equipment and workstations, including shock mounts if used, must be tested for vibration response per the tailored requirements of MIL-STD-167/1. Equipment shall be subjected to endurance testing at fixed frequencies based upon the critical frequencies determined from the vibration response testing. When vibration response investigation does not identify any critical frequencies, testing shall be conducted at the maximum vibration frequency of 50 Hz and .076 mm vibration amplitude.

4.4.5.6 Electromagnetic susceptibility

Electromagnetic susceptibility requirements shall be tailored in accordance with MIL-STD-461. The equipment shall not be susceptible to electromagnetic emission in the room or area in which it is installed.

4.4.5.7 Electromagnetic emissions

Electromagnetic emissions requirements shall be tailored in accordance with MIL-STD-461. Electromagnetic emissions tests shall be tailored in accordance with MIL-STD-462. COTS equipment may be procured to FCC Class A or B regulations in accordance with 47 CFR15, and modified to conform to the requirements of the shipboard installation, through application of EMI filters and shielding

4.4.5.8 Fungus/mold

The equipment shall not support fungal or mold growth. Fungus/mold tests shall be tailored in accordance with MIL-STD-810.

4.4.5.9 Salt Fog

Equipment shall be tested to withstand salt fog when used in shipboard locations that are susceptible to salt fog conditions. Salt fog tests shall be tailored in accordance with MIL-STD-810.

4.5 Shore-based Facility Requirements

Shore-based Naval installations are located in virtually every geographic area, with a broad range of mission requirements and environmental conditions. Consequently, facility engineers consider each information technology facility’s unique requirements, and custom engineer facilities to satisfy requirements within the constraints of security, construction standards, equipment requirements and available space.

4.5.1 Architectural Components:

Architectural component standards comprise the building blocks that the information technology building or facility is built around. Where IEEE, ITU, MIL SPEC, or other standards apply, they are listed after the component description.

- Walls – drywall, masonry, plaster.
- Ceiling – drywall, suspended, plenum.
- Flooring – generally raised floor system (must be grounded).
- Finishes:
  - Carpet – must be static controlled.
  - Vinyl floor tile must be conductive floor finish.
- Additionally, the following generic points apply to all information technology facilities.
- All ceiling, wall and floor penetrations must be sealed.
- Door Hardware – security requirements may call for specialized entry systems.
- Sufficient space to easily move around the equipment.

4.5.2 Fire Protection Components:

Information technology computing and data storage equipment represents a significant investment that must be protected from catastrophic failure due to fire. Due to factors that are designed to protect human life and data integrity, traditional fire-fighting measures such as Halon extinguishers or water are unacceptable. Additionally, power-kill-switches are highly recommended. Standards for fire protection components are:

- CO_2
- Emergency Power cut off may be required for some systems

4.5.3 Mechanical Components:

Mechanical components incorporate environmental controls, and physical housing for equipment. Associated standards are:

- Critical humidity control in accordance with equipment manufacturer's recommendations
- High Volume Air Conditioning or individual room units control in accordance with equipment manufacturer's recommendations
- Special equipment noise restrictions.

4.5.4 Electrical Components

Power requirements for commercial and military information technology equipment vary widely dependent on geographic location (US 115VAC, EUR 220VAC), direct current versus alternating current, and requirements for availability under adverse circumstances. The guidance below lists factors that must be considered for supplying this critical component.

- Power systems – may require red/black power for security
- May require separate 20 amp service for the network equipment and servers
- Uninterrupted Power Supply (UPS) dependent upon service or data criticality
- Individual panel boards with shunt trip circuit breakers
- Specialized cabling requirements
- Specialized lighting requirements
  - Direct or indirect
  - Type of lighting fixtures
- In order to ensure that your specific requirements are satisfied the following references for electrical systems address military and commercial standards:
  - MIL-HDBK-1004/1 Preliminary Design Considerations.
  - MIL-HDBK-1004/2A Power Distribution Systems.
  - MIL-HDBK-1004/3 Switch gear and Relaying.
  - MIL-HDBK-1004/4 Electrical Utilization Systems.
  - MIL-HDBK-1004/5 400 Hz Mcd-Volt. Conversion/Distribution & Low Voltage Systems.
  - MIL-HDBK-1004/6 Lightning and Cathodic Protection.
  - MIL-HDBK-1004/7 Wire Communications & Signal Systems.
  - MIL-HDBK-1008C Fire Protection for Facilities Engineering.
  - MIL-HDBK-1012/1 Electronics Facilities Engineering.
  - MIL-HDBK-1012/3 Telecommunications Premises Distribution Plan, Design.
  - DM 13.02 Commercial IDS.
  - ANSI C2 1997 National Electrical Safety Code.
  - NFPA 70 1996 National Electrical Code.
  - NFPA 72 1993 National Fire Alarm Code.
  - NFPA 780 1995 Lightning Protection Code.

4.6 Ground Combat Environment

Computers and communication equipment to be used in ground combat operations should be ruggedized and portable. This section will be completed in future versions of the ITSG.

4.7 Naval Aircraft Environment

Commercial off-the-shelf (COTS) equipment can reliably operate within enclosed air-conditioned spaces of aircraft facilities provided that some reasonable and practical installation guidelines are followed. Aircraft have very unique requirements that should be addressed by the program manager (PMA) for the applicable platform. Even different versions of the same aircraft platform may have specific requirements that differ significantly from previous versions.

At a minimum, the following areas should be addressed when considering application of COTS information technology solutions onboard DON aircraft:

- Racks
- Cooling
- Shock Isolation
- Vibration
- C/G effects
- Line Conditioning and UPS
- Electrical system interfaces
- HVAC system interfaces
- Satellite antenna interfaces
- A/C data bus interfaces

4.8 References

4.8.1 Standards and Specifications Resources

4.8.1.1 Security

Secretary of the Navy (SECNAV), “Department of the Navy Information Security (INFOSEC) Program” SECNAVINST 5239.3; 14 July 1995; http://www.cnet.navy.mil/tralant/scnv5239.pdf (23 May 1997)

Department of Defense (DoD); “National Industrial Security Program Operating Manual (NISPOM)”, January 1995; http://www.fas.org/sgp/library/nispom.htm (23 May 1998)

Department of Defense (DOD) MIL-STD-461D “Electromagnetic Interference Emissions and Susceptibility, Requirements for,” 11 January 1993, www.library.itsi.disa.mil/org/mil_stdb/ms461d.html (23 May 1998)

National Security Agency (NSA); “National Security Telecommunications and Information Systems Security Advisory Memorandum (NSTISSAM) TEMPEST 2/95, RED/BLACK Installation Guidance”; 12 December 1995

4.8.1.2 Shipboard Cable Plant

Naval Sea Systems Command (NAVSEA) “NIIN IPT Near-Term Guidance for Shipboard Networks”; 11 November 1997

Naval Sea Systems Command (NAVSEA) “Shipboard Cable Plant Management System Functional Specification” 29 November 1996

Department of Defense (DOD) MIL-STD-167/1 “Mechanical Vibrations of Shipboard Equipment (Type I & II)” 1 September 1993, http://diamond.spawar.navy.mil/specs/mil_std/MIL_STD_167.html (23 May 1998)

Department of Defense (DOD) MIL-STD-461D “Electromagnetic Interference Emissions and Susceptibility, Requirements for,” 11 January 1993 Web: library.itsi.disa.mil/org/mil_stdb/ms461d.html (23 May 1998)

Department of Defense (DOD) MIL-STD-462 “Electromagnetic Interference Characteristics, Measurement of” 11 January 1993, www-library.itsa.disa.mil/org/mil_stdb/ms462d.html

Department of Defense (DOD) MIL-STD-810E “Environmental Test Methods and Engineering Guidelines” 1 September 1993, www-library.itsa.disa.mil/org/mil_stdb/ms810e.html

MIL-STD-2042

MIL-HDBK-2051

DOD-STD-1678

MIL-T-29504/14 &/15

MIL-F-49291

MIL-C-85045

MIL-I-24728

MIL-C-28876

MIL-S-24623

MIL-C-83522/16

4.8.1.3 Shore Base Cable Plant

American National Standards Institute (ANSI)/Telecommunications Industry Association (TIA)/Electronics Industries Alliance; Standard 568A: Commercial Building Telecommunications Cabling Standard, October 1995, http://www.cis.ohio-state.edu/hypertext/faq/usenet/LANs/cabling-faq/faq-doc-9.html (23 May 1998) and http://diamond.spawar.navy.mil/cabling/C_2_1.html (23 May 1998)

American National Standards Institute (ANSI)/Telecommunications Industry Association (TIA)/Electronics Industries Alliance; Standard 569: Commercial Building Standards for Telecommunications Pathways and Spaces; October 1990; http://diamond.spawar.navy.mil/cabling/C_2_5.html (23 May 1998)

4.8.1.4 Shipboard Electrical System

DOD-STD-2003

MIL-HDBK-299

MIL-STD-1680

MIL-STD-1310

MIL-S-24729

4.8.1.5 Shipboard Air Conditioning

Naval Sea Systems Command; NAVSEA 0938-LP-018-0010: Shipboard Air Conditioning.

4.8.1.6 Shore Electrical System

Department of Defense (DOD) MIL-HDBK-1004/1 Preliminary Design Considerations;

Department of Defense (DOD) MIL-HDBK-1004/2A Power Distribution Systems;

Department of Defense (DOD) MIL-HDBK-1004/3 Switch gear and Relaying;

Department of Defense (DOD) MIL-HDBK-1004/4 Electrical Utilization Systems;

Department of Defense (DOD) MIL-HDBK-1004/5 400 Hz Mcd-Volt. Conversion/Distribution & Low Voltage Systems;

Department of Defense (DOD) MIL-HDBK-1004/6 Lightning and Cathodic Protection;

Department of Defense (DOD) MIL-HDBK-1004/7 Wire Communications & Signal Systems;

Department of Defense (DOD) MIL-HDBK-1008C Fire Protection for Facilities Engineering;

Department of Defense (DOD) MIL-HDBK-1012/1 Electronics Facilities Engineering.

Department of Defense (DOD) MIL-HDBK-1012/3 Telecommunications Premises Distribution Plan, Design.

DM 13.02 Commercial IDS

American National Standards Institute (ANSI); ANSI C2-1997: “National Electrical Safety Code”; 1967; www.nssn.org (23 May 1998)NFPA 70 1996 National Electrical Code.

National Fire Protection Association (NFPA); Document 70: “National Electrical Code” 1996, www.nfpa.org (23 May 1998)

National Fire Protection Association (NFPA); Document 72: “ National Fire Alarm Code” 1993, www.nfpa.org (23 May 1998)

National Fire Protection Association (NFPA); Document 780: “Lightning Protection Code” 1995, www.nfpa.org/ (23 May 1998)

4.8.1.7 Shipboard SATCOM Equipment

Navy UHF Satellite Communications System Description, FSCS-200-83 of 1 August 1984

Navy SHF Satellite Communications System Description, NSHFC 301 of November 1983

AN/WSC-6(V) Navy 8kW SHF SATCOM literature from Raytheon Company.

AN/USC-38(V) Navy EHF SATCOM Terminal literature from Raytheon Company

4.8.2 Supporting Resources

Additional information can be found at the Web sites listed below.

Heavy-Duty Equipment Racks for Shipboard Use

Equipto Electronics Corporation web site; www.equiptoelec.com (23 May 1998)

Shock Mounts for Shipboard Racks

Aeroflex International Inc web site; www.aeroflex.com (23 May 1998)

UPS and Power Conditioners for Shipboard Use

American Power Conversion (APC) web site; www.apcc.com (23 May 1998) (Their X93 series has been specially modified to meet floating neutral wiring shipboard wiring requirements.)

Clary Corporation web site; www.clary.com (23 May 1998)